S P E C I F I C A T I O N

TITLE OF THE INVENTION

Temperature Control Apparatus

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a temperature control apparatus for controlling the temperature of another apparatus and, more particularly, to a temperature control apparatus for cooling a semiconductor manufacturing apparatus such as an etching apparatus by exchanging the heat between a heat exchanger for passing a liquid (or a temperature controlling fluid) fed from the outside and a heat exchanger for passing a circulating liquid (or a temperature controlled fluid) and by using this circulating liquid.

Related Art

The temperature control apparatus of the prior art, as used for cooling a semiconductor manufacturing apparatus such as an etching apparatus, is provided with a heat exchanger unit 30, as shown in Fig. 3. This heat exchanger unit 30 includes: a cooling water heat exchanger (or a temperature controlling heat exchanger) having a cooling water passage 31 formed for passing the cooling water fed from the outside; and a circulating liquid heat exchanger (or a temperature controlled

heat exchanger) having a (not-shown) circulating liquid passage formed for passing a circulating liquid to be circulated between itself and the etching apparatus, so that the heat is exchanged between the cooling water heat exchanger and the circulating liquid heat exchanger. The cooling water passage 31 is connected through a joint 33 to a pipe 36 connected to the outside. For this connection, there are used two nuts 34 and 35 which are attached to the joint 33.

In this temperature control apparatus of the prior art, however, a space is needed for turning the nuts 34 and 35 so that there is a problem that the space efficiency is poor. Where the heat exchange unit 30 is arranged in a narrow space, on the other hand, the nuts 34 and 35 are hard to be turned thereby raise another problem that the maintainability is poor. Moreover, the heat exchanger is fixed at its two ends to raise another problem that the thermal distortion in the heat exchanger cannot be absorbed.

On the other hand, it is conceivable to connect a connecting pipe to a cooling water passage and to connect the connecting pipe to a passage block by fitting it and further to the pipe 36 through a passage block. With this construction, however, the passage block and the heat exchange unit have to be precisely machined and that leads to rise in cost.

Alternatively, it is conceivable to attach the connecting pipe to the passage block removably by means of bolts.

With this construction, however, it is impossible to absorb the distortion of the heat exchanger, as caused by the thermal expansion or shrinkage.

SUMMARY OF THE INVENTION

In view of the discussion thus far described, therefore, the present invention has an object to provide a temperature control apparatus having the structure which is easy in the replacement of a heat exchange unit to enhance the maintainability and the space efficiency and which can absorb the distortion of a heat exchanger due to the thermal expansion or shrinkage.

In order to solve the above-specified problems, according to a first aspect of the invention, there is provided a temperature control apparatus which comprises: a temperature controlling heat exchanger having a passage for passing a temperature controlling fluid; a connecting pipe connected to the passage of the temperature controlling heat exchanger; a passage block having a passage for passing a temperature controlling fluid to the temperature controlling heat exchanger; a relay block for forming a passage between the passage of the passage block and the connecting pipe; and sealing means for connecting the connecting pipe movably to the passage of the relay block. In the temperature control apparatus, the length of the connecting pipe is made

substantially equal to or slightly shorter than the spacing between the temperature controlling heat exchanger and the first block.

According to a second aspect of the invention, on the other hand, there is provided a temperature control apparatus which comprises: a temperature controlled heat exchanger having a passage for passing a temperature controlled fluid; a connecting pipe connected to the passage of the temperature controlled heat exchanger; a passage block having a passage for passing a temperature controlled fluid to the temperature controlled heat exchanger; a relay block for forming a passage between the passage of the passage block and the connecting pipe; and sealing means for connecting the connecting pipe movably to the passage of the relay block. In the temperature control apparatus, the length of the connecting pipe is made substantially equal to or slightly shorter than the spacing between the temperature controlled heat exchanger and the first block.

According to a third aspect of the invention, on the other hand, there is provided a temperature control apparatus which comprises a heat exchange unit for exchanging the heat between a temperature controlling heat exchanger having a passage for passing a temperature controlling fluid and a temperature controlled heat exchanger having a passage for passing a temperature controlled fluid. The temperature control

apparatus has both the features of the temperature control apparatus according to the first aspect and the features of the temperature control apparatus according to the second aspect.

According to the invention, the relay block has the passage between the passage block and the connecting pipe of the heat exchange unit, and the length of the connecting pipe is substantially equal to or slightly shorter than the spacing between the heat exchanger and the passage block. Where the heat exchange unit is troubled, therefore, the troubled heat exchange unit can be easily replaced by a new one by removing the relay block connected to the troubled heat exchange unit from the passage block. On the other hand, the connecting pipe of the heat exchange unit is connected to the passage of the relay block by using the sealing means that mentioned above so that the distortion of the heat exchanger due to the thermal expansion or shrinkage can be absorbed.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a top plan view showing the interior of a temperature control apparatus related to one embodiment of the invention;

Figs. 2A and 2B are views showing the construction of a heat exchange unit of Fig. 1 in details, Fig. 2A is a top plan view of one column of the heat exchange unit, and Fig.

2B is a side elevation of one column of the heat exchange unit; and

Fig. 3 is a top plan view showing a portion of the temperature control apparatus of the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Here will be described an embodiment of the invention with reference to the accompanying drawings.

Fig. 1 is a top plan view showing a temperature control apparatus according to one embodiment of the invention. In this embodiment, the invention is applied to a temperature control apparatus for cooling an etching apparatus. As shown in Fig. 1, this temperature control apparatus is provided with heat exchange units 10 which are arrayed in two columns in the horizontal direction. The heat exchange unit 10 is so removably attached to a casing 1 of the temperature control apparatus that it can be replaced, when troubled, by a new one.

Figs. 2A and 2B are showing the construction of this heat exchange unit in detail. Fig. 2A is a top plan view of one column of the heat exchange unit, and Fig. 2B is a side elevation of one column of the heat exchange unit. As shown in Fig. 2B, the heat exchange units 10 are vertically stacked at two steps so that totally four heat exchange units are disposed in the temperature control apparatus. Here, these heat exchange units may be arrayed at four steps either in the vertical

direction or in the horizontal direction.

In one heat exchange unit 10, a cooling water heat exchanger (or a temperature controlling heat exchanger) 11 having a cooling water passage 31 formed for passing the cooling water fed from the outside and a circulating liquid heat exchanger (or a temperature controlled heat exchanger) 12 having a (not-shown) circulating liquid passage formed for passing a circulating liquid to be circulated between itself and the etching apparatus are alternately stacked vertically through thermoelectric modules 13, so that a heat is exchanged between the cooling water heat exchanger 11 and the circulating liquid heat exchanger 12. Here, this embodiment provides the two cooling water heat exchangers 11 above and below one cooling water heat exchanger 12.

When an electric current is fed to the thermoelectric module 13, the heat migrates from the circulating liquid heat exchanger 12 to the cooling water heat exchanger 11. As a result, the circulating liquid flowing in the circulating liquid passage is cooled down so that the heat is drained to the cooling water flowing in the cooling water passage. The cooling water may be always renewed by new one or may be circulated with the outside.

To each of the inlet port and the outlet port of the cooling water passage of the cooling water heat exchanger 11, there is connected each connecting pipe 21, each of which is

connected to one relay block 15 by using an O-ring 14, for example, as sealing means. By using such a sealing member, it is possible to absorb the distortion that is caused by the thermal expansion or shrinkage of the heat exchanger. In addition, the connecting pipe 21 is tapered in the vicinity of its inlet or outlet port to prevent the heat exchange unit 10 from moving more than requirement. The tapered structure of the connecting pipe 21 may be replaced by a stopper for preventing the heat exchange unit 10 from moving more than requirement.

As shown in Fig. 2B, the eight connecting pipes 21, as connected to the four cooling water heat exchangers 11 of the two heat exchange units 10, are individually connected to the eight relay blocks 15. Moreover, these eight relay blocks 15 are fixed to one cooling water passage block 16 which is fixed in the casing 1. As shown in Fig. 1, the relay blocks 15, as connected to the other two heat exchange units, are also fixed to the same cooling water passage block 16. Here, the length of the connecting pipe 21 is made substantially equal to or slightly shorter than the spacing between the cooling water heat exchanger 11 and the cooling water passage block 16. When the heat exchange unit is troubled, therefore, this troubled heat exchange unit can be easily replaced by a new one by removing the relay block 15 connected to the troubled heat exchange unit from the cooling water passage block 16.

In order to fix the relay block 15 and the cooling water passage block 16, for example, a bolt 17 shown in Fig. 2A is used as the fixing member. The bolt 17 is inserted into a hole formed in the cooling water passage block 16 and is fastened to the relay block 15. If the bolt 17 can be thus turned from the outside of the casing, the replacement of the heat exchange unit can be further facilitated. If the inside diameter of the hole formed in the cooling water passage block 16 is made larger than the diameter of the bolt 17, on the other hand, it is possible to absorb the dimension errors in those blocks or heat exchange units.

On the other hand, the circulating liquid heat exchanger 12 is also connected to a relay block 18 same as in the case of the cooling water heat exchanger 11. As shown in Fig. 1, a plurality of relay blocks 18 are fixed to one circulating liquid passage block 19. In the temperature control apparatus, moreover, there are arranged a tank 23 for reserving the circulating liquid, a pump 24 for circulating the circulating liquid, and a motor 25 for driving the pump 24. Moreover, a tank 23 for reserving the circulating liquid, a pump 24 for circulating the circulating liquid, and a motor 25 for driving the pump 24 are arranged in the temperature control apparatus.

According to the present invention, as apparent from the description mentioned above, the connecting pipe of the heat exchange unit is connected to the plurality of relay blocks,

which are fixed to the passage block, and the length of the connecting pipe is substantially equal to or slightly shorter than the spacing between the heat exchanger and the passage block so that the heat exchange unit can be replaced by removing the relay block from the passage block. Therefore, the heat exchange unit can be easily replaced to enhance the maintainability and the space efficiency. On the other hand, the connecting pipe of the heat exchange unit is movably connected to the passage of the relay block by using the sealing means such as the O-ring so that the distortion due to the thermal expansion or shrinkage of the heat exchanger can be absorbed.

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